How is a solid rocket propellant manufactured?

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3 Answers

Gabriel Balensiefer, Aerospace radiographer, observer of much.
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A cylindrical case is manufactured.

A mandrel is fabricated to fit inside the case.

Aluminum powder and fine grained ammonium perchlorate are mixed together (literally like an oversized kitchen mixer) with a binder to form a fluid propellant.

The mandrel is inserted into the upright case.

The propellant is “cast” around the mandrel, then cured (solidified).

The mandrel is extracted, leaving behind the bore and fins (fins control burn rate by increasing surface area of the burn surface).

Nozzle is assembled.

Igniter is installed.

Rocket motor is attached to main vehicle.

Launch.

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E. Milton Wilson, former Manager, Chemical Division at Aerojet (1950-1974)
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Ah, spent 10 years of my life doing this or at least watching it be done. Picture a very large bread dough blender and start carefully adding about 10 ingredients to it. The recipe is far more complicated than you would guess and we chemists spent years developing the best. Not too quick to cure up to a firm solid so you could pour the batch into molds shaped for designed burning qualities. Typically contained an oxidizer such as ammonium perchlorate, a resin base as a fuel that was a polymer and got firm as its chemistry took place, aluminum powder as a fuel, and several burning rate additives. More details later for those interested.

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There are many type of solid propellants. However, the most common are type of plastic material where a binder cross-links the oxidizer and the fuel into a polymer that looks like and smells like…. Plastic. So, all the manufacturing procedures that are used in the plastic industry are utilized. For example, casting, extrusion and even mold injection methods are used. Rarely, for one of a kind prototype they even used remotely controlled machining. The shelf life of propellants manufactured in these methods display long term stability which also affect the reliability of the final products favorably. The most common solid propellants produced today are called “composites”.

However, soon after WWII, the most common solid propellants were made from double-base., and were produced in the methods mentioned earlier. The energy density of this propellant (i. e., specific impulse) is higher than that of the composite type. But its shelf life was much shorter. Perhaps the best image to the double-base propellants is: “you mix it and knead it like a cake; you bake it like a cake, and throw it away when stale, just like a cake”…

For a long time the Holy grail of solid propellant rockets was a double-base propellant with specific impulse of 300 seconds that displays stable shelf life. But they still use composite propellants with only 270 seconds specific.